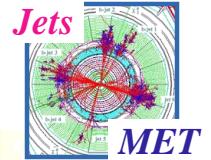




# UPDATE ON SUSY TRIGGER OPTIMIZATION



S.Abdullin, UMD



## ■ Talk at CMS week :

[http://cmsdoc.cern.ch/~abdullin/jetmet/meetings/cmsweek\\_dec01/SUSY\\_HLT.pdf](http://cmsdoc.cern.ch/~abdullin/jetmet/meetings/cmsweek_dec01/SUSY_HLT.pdf)

## ■ Talk at Jets/MET meetings (20 Dec 2001, 13 Feb 2002) :

<http://cmsdoc.cern.ch/~abdullin/jetmet/meetings/20dec01/talk.pdf>

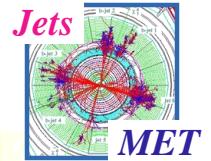
[http://cmsdoc.cern.ch/~abdullin/jetmet/meetings/13feb02/L2\\_susy\\_update.pdf](http://cmsdoc.cern.ch/~abdullin/jetmet/meetings/13feb02/L2_susy_update.pdf)

## ■ Optimization algorithm written and tested, a few probing points analysed

## ■ Now concentrate on Tevatron reach in mSUGRA model

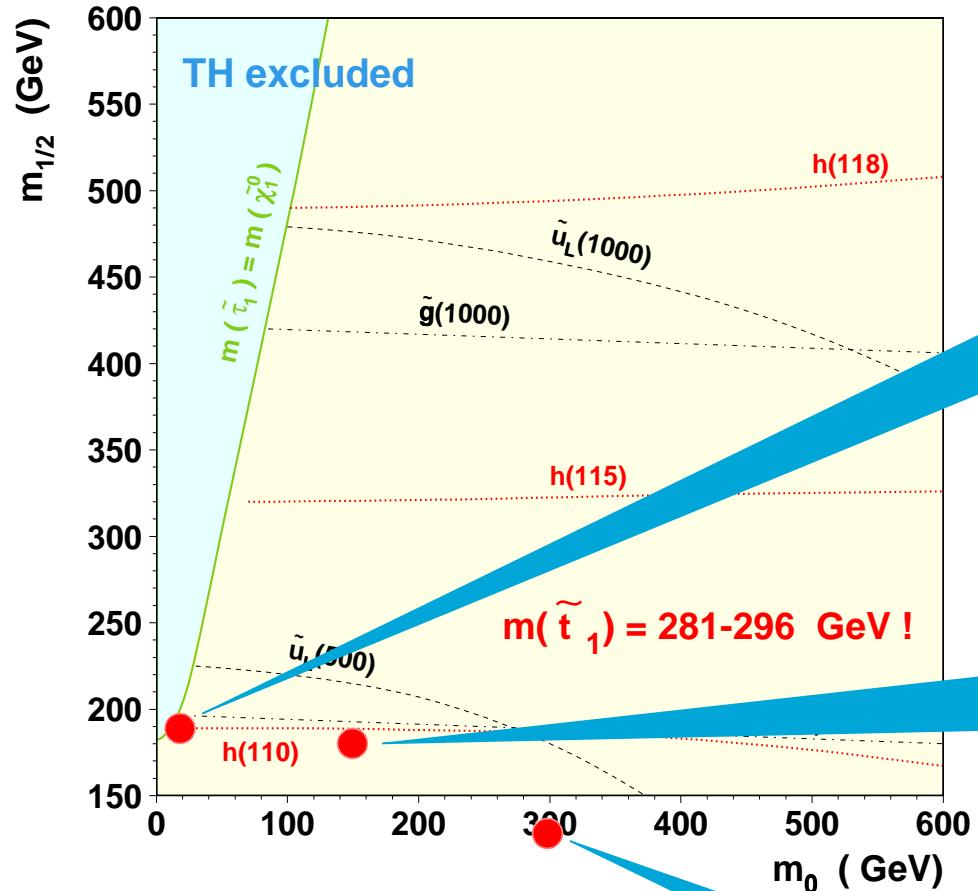
## ■ "Global optimization" is possible ?

# WHERE THE TEVATRON REACH ENDS ...



H.Baer et al., hep-ph/9802441; Phys.Rev.D58:075008, 1998

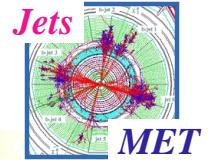
$A_0 = 0, \tan\beta = 10, \mu > 0$



Require  $\int L dt < 10 \text{ pb}^{-1}$



# R-PARITY VIOLATION SCENARIO ...



- 👉 To avoid coupling of fermions to sfermions and fermions simultaneously (lepton and/or barion number non-conservation)

$$R = (-1)^{3(B-L) + 2S}$$

- 👉 Consequences :

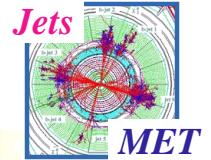
- sparticles produced in pairs
- lightest sparticle (LSP) is stable
- interactions of particles and sparticles can differ

- 👉 Here the simplest (and most challenging) case of R-parity violation is considered :

- $\tilde{\chi}_1^0 \rightarrow 3 \text{ quarks}$
- one might expect 6 additional jets ?



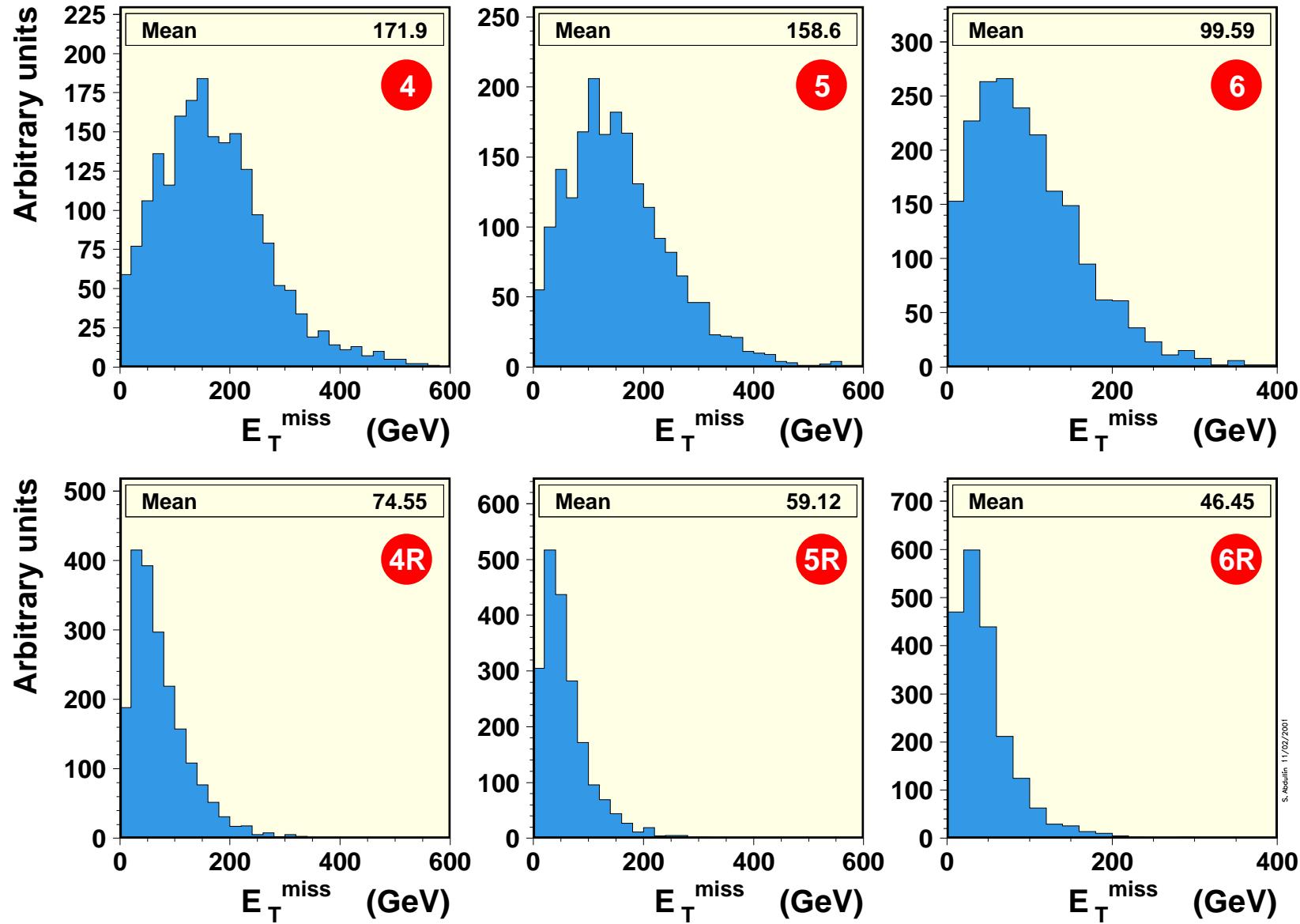
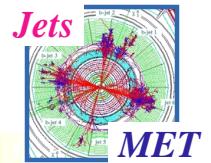
# THE SAME 3 PROBING POINTS, BUT WITH R-PARITY



- The same 3 "Tevatron reach" points underwent a "surgery" with the help of **ISAJET 7.51**  
 **ISAWIG 1.104**  
 **HERWIG 6.301**  
to eventually acquire R-parity broken : Points **4R** **5R** **6R**
- MET shrinks (no  $\tilde{\chi}_1^0$ ) but not completely
  - copious b-jet production (lightest stop and sbottom)
  - for  $\tan \beta > 5$  increasing  $\tau$  couplings :  $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow \tau(\tau) + x$
  - W's from both top and sparticle decays
- Additional jets are expected to be rather soft ...
  - $m(\tilde{\chi}_1^0) = 45\text{-}70 \text{ GeV}$

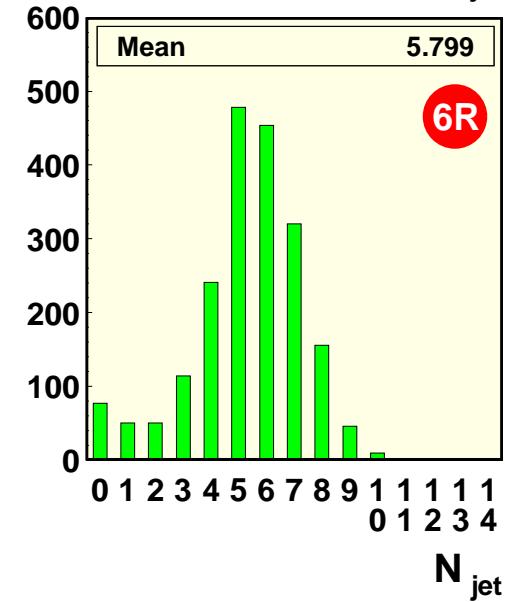
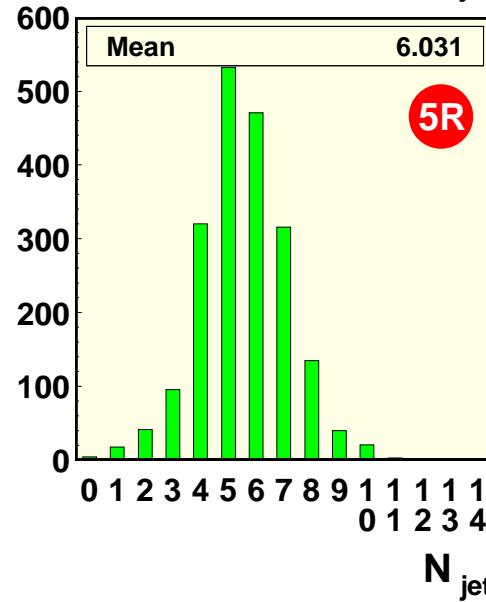
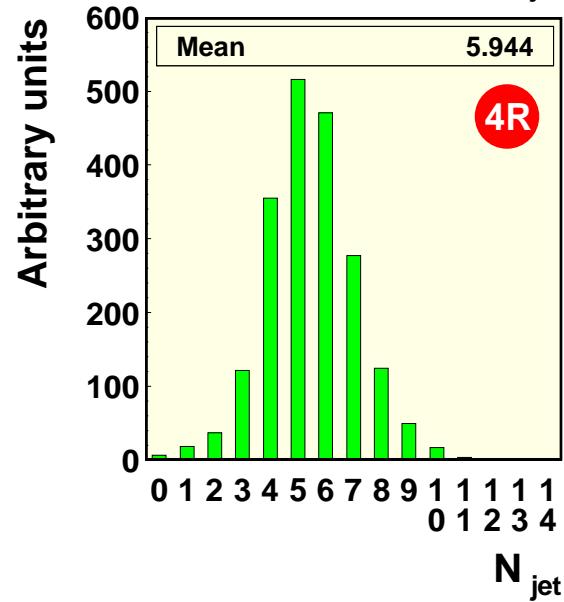
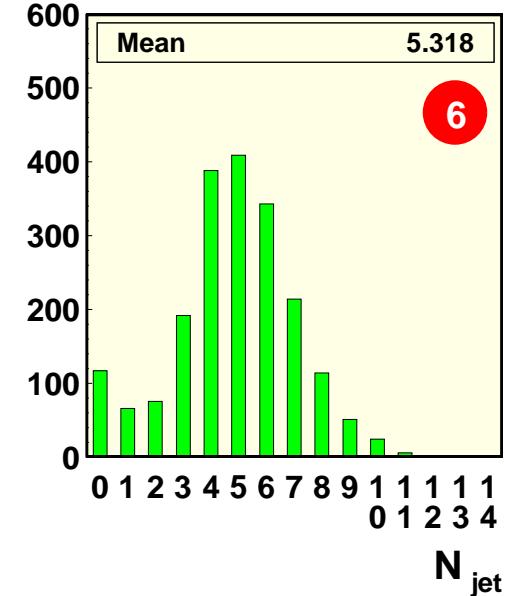
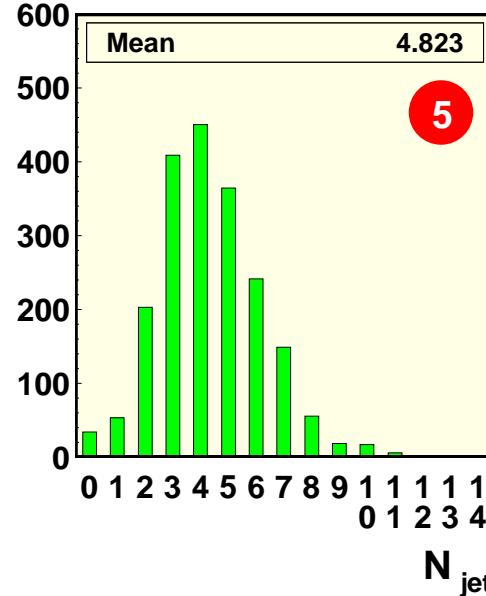
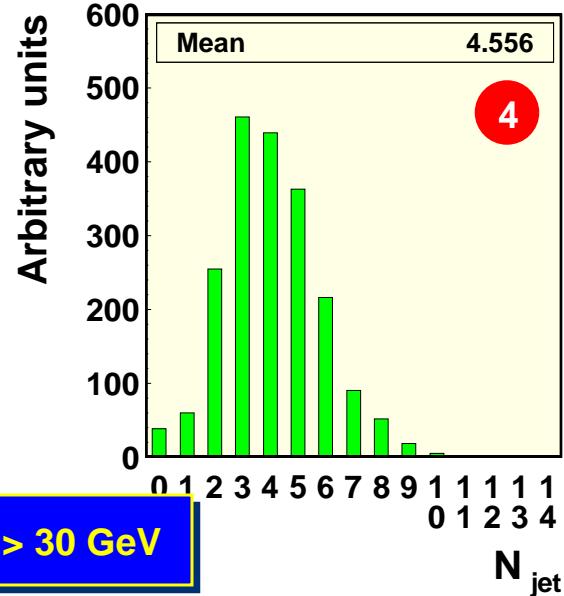
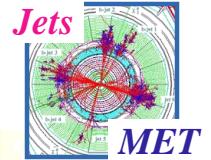


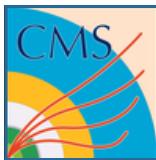
# L2 DISTRIBUTIONS : TOWER MET



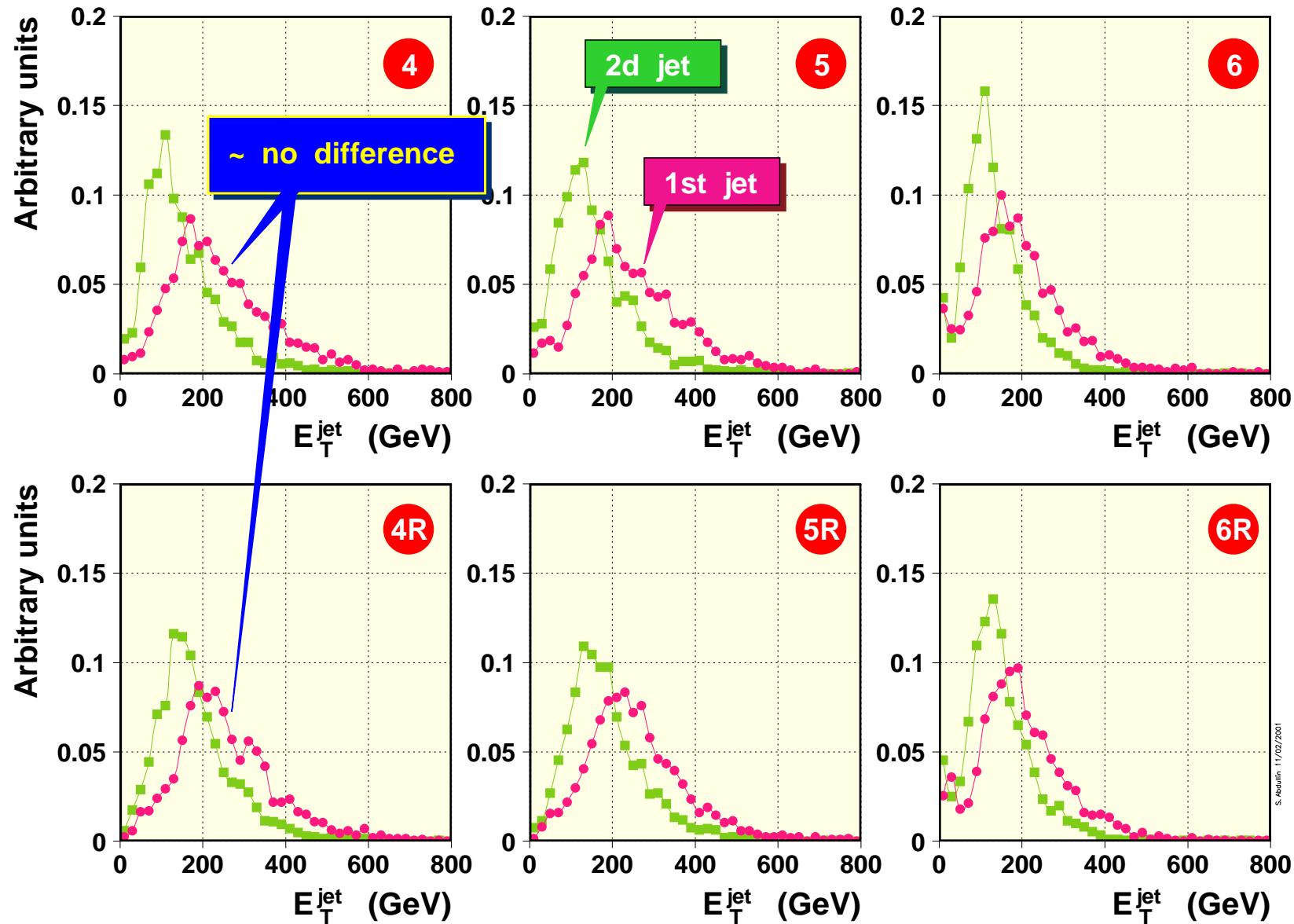
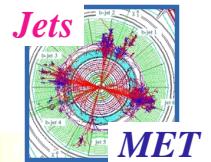


# DISTRIBUTIONS : NUMBER OF JETS (L2)

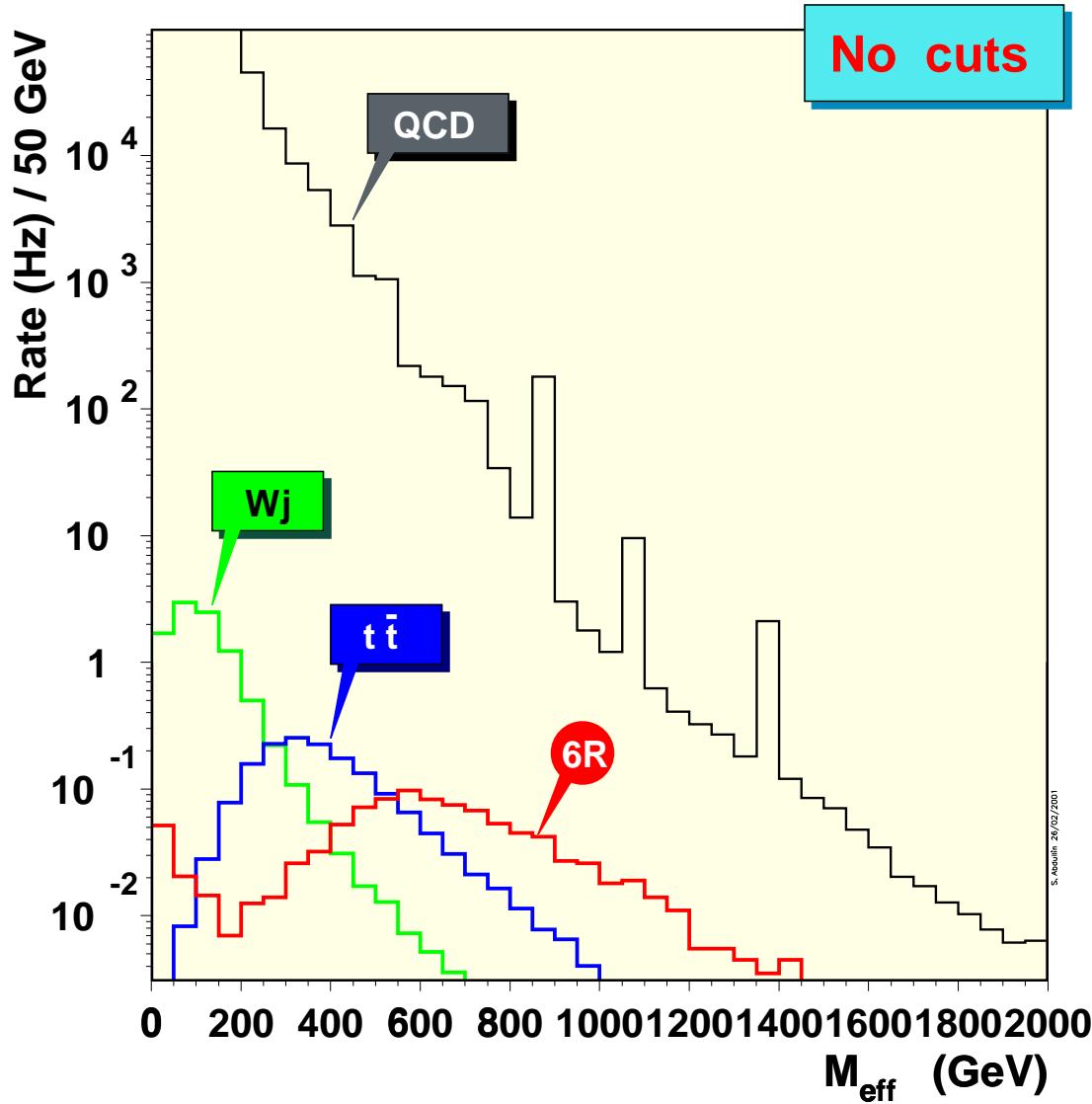
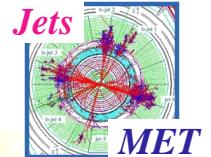




# L2 DISTRIBUTIONS : LEADING JETS

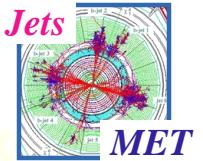


# L2 DISTRIBUTIONS : TRANSVERSE MASS

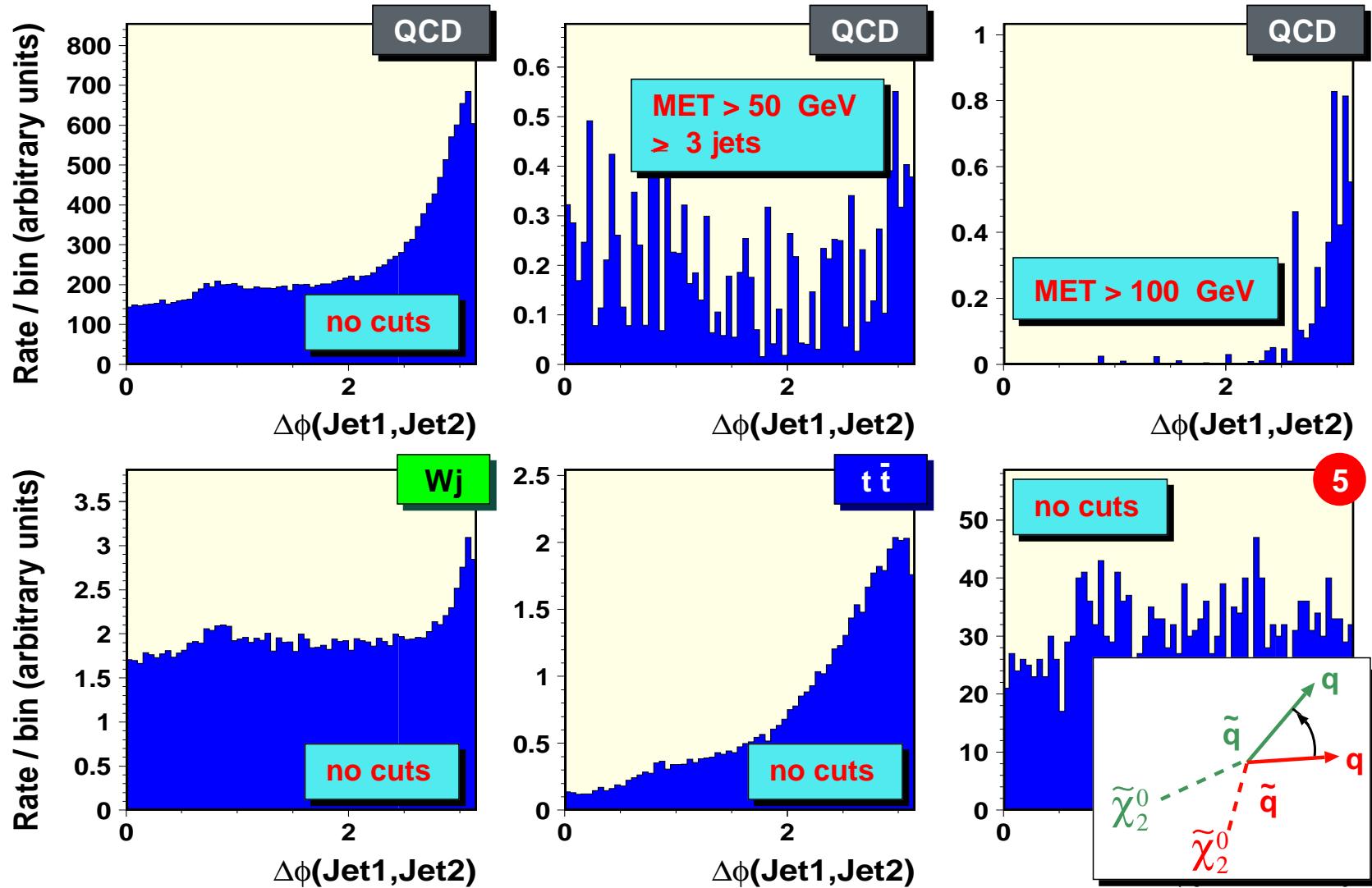


- ☞  $\text{MET} + \sum E_T^{\text{jet}} (> 30 \text{ GeV})$
  - shapes differ ...
  - might be useful in combination with other cuts ?
- 
- ☞ Running ahead - doesn't help ...

# L2 DISTRIBUTIONS : $\Delta\phi(\text{Jet1}, \text{Jet2})^*$

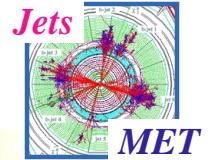


\* inspired by considerations for invisible Higgs (A.Nikitenko, K. Mazumdar)  
and QCD rate suppression (P.Hidas)  
<http://computing.fnal.gov/cms/jpg/minutes/feb2002/kunori/met.pdf> (pp. 11,12)





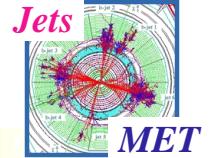
# HOW HIGH RATE COULD WE AFFORD



- Something like ~ 4 kHz for Jets/MET @ L1 (?)
  - 2 + 2 for tau physics and other jets/MET channels
- Something like ~ 6 Hz for Jets/MET @ L2 (?)
  - 3 + 3 for tau physics and other jets/MET channels
- Assuming 3 Hz at our disposal :
  - MET + 1-2 jets       $m(\text{gluino}) >> m(\text{squark})$
  - MET + 3-4 jets       $m(\text{gluino}) \sim m(\text{squark})$
  - 4 or more jets       $m(\text{gluino}) < m(\text{squark})$  or  $\cancel{R}\text{-parity}$   
and small MET
- As we don't know what the SUSY might look like,  
probably we should try to cope with "everything" ...



# A FEW MORE WORDS ABOUT BACKGROUND



**QCD**

- $> 10^6$  events in 22  $\hat{p}_T$  bins
- $0 < \hat{p}_T < 4000$  GeV
- average Branson weights for rate calculation
- not completely cleaned up ...
- $\sigma = 55$  mb



**t  $\bar{t}$**

- 46,000 events
- no forced decays
- $\sigma = 800$  pb

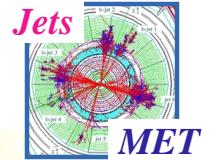


**W j**

- 146,397 events
- $W \rightarrow l \nu$
- $\hat{p}_T > 30$  GeV
- $\sigma * \text{Br} = 4.68$  nb



# A SIMPLE GENETIC ALGORITHM



- "Society of individuals" (fixed-size population ~ 100) with some established hierarchy, e.g. descending ordering of certain function of parameters ("genes") with a few "behaviour" functions defined

- breeding
- mutation
- "death / birth"
- selection

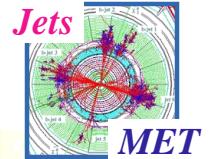
*might be a variety of definitions*

- A generation-by-generation process ...

- more details in  
<http://cmsdoc.cern.ch/~abdullin/jetmet/meetings/20dec01/talk.pdf>



# ALGORITHM PERFORMANCE



## ■ Use of cuts

- L1 : MET, J1, J2, J3, J4, (J1.AND.MET) via .OR.
- L2 : [ (J1.AND.MET).OR.(J2.AND.MET).OR.(J3.AND.MET).OR.(J4.AND.MET).OR.MET ] .AND.  $\Delta\phi$  (J1,J2)

## ■ Typically a few hundred generations to reach stability ...

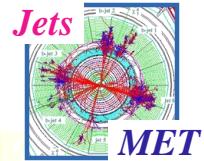
- a few tens of "cost" calculations per each generation
- L1 job takes ~ 30 min (650 MHz PIII)
- L2 job takes ~ 15 min

## ■ How much would it take to consider all cuts combinations ...

	N param.	N combin.	Time (s)	Total time
L1	6	$1.5 * 10^8$	0.5	~ 2 years
L2	10	$1.0 * 10^{13}$	0.1	$2 * 10^4$ years



# L1 CUTS OPTIMIZATION

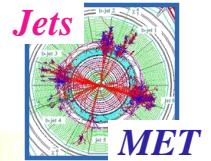


## Jets and MET $E_T$ cuts (GeV) for optimal signal efficiency @ L1

	MET 90	J1 190	J2 150	J3 70	J4 50	J1 + MET 80 + 70
signal efficiency (%)	Point 4      71.4(71.4)	81.7(64.8)	82.5(42.5)	86.5(50.2)	86.8(31.5)	<u>89.7</u> (79.3)
	Point 5      67.4(67.4)	79.2(65.2)	80.5(45.4)	85.6(54.2)	86.4(35.4)	<u>89.4</u> (78.0)
	Point 6      40.8(40.8)	60.1(47.7)	62.2(33.8)	74.1(57.2)	75.3(42.9)	<u>78.9</u> (55.5)
	Point 4R      32.6(32.6)	77.6(74.7)	81.2(65.3)	90.5(83.2)	91.4(69.9)	<u>92.1</u> (46.0)
	Point 5R      21.7(21.7)	76.9(75.4)	80.2(65.9)	91.6(84.4)	92.2(71.1)	<u>92.7</u> (35.3)
	Point 6R      14.1(14.1)	55.0(53.5)	60.0(47.0)	81.8(75.8)	84.0(64.8)	<u>84.5</u> (24.0)
Background rate (kHz)	QCD	0.05(0.05)	0.69(0.65)	0.77(0.27)	1.70(1.20)	1.79(0.34)
	$t\bar{t}$					<u>2.01</u> (0.31)
$W j(l_V)$		}				
irrelevant !						



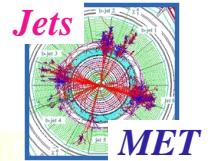
# L2 CUTS OPTIMIZATION



	MET	J1 + MET	J2 + MET	J3 + MET	J4 + MET	eff. w.r.t. L1 $\Delta\phi(J1,J2) < 125^\circ$	L2 rate (Hz)
	140	210 + 0	150 + 0	30 + 100	50 + 70		
Point 4	45.0(45.9)	58.6(42.1)	60.8(31.1)	65.4(49.8)	<b>66.0</b> (24.3)	0.704*	0.21
Point 5	38.8(38.8)	54.3(42.5)	56.3(32.4)	61.1(46.4)	<b>62.5</b> (27.0)	0.685	0.24
Point 6	19.5(19.5)	42.8(34.8)	47.1(28.7)	53.6(32.7)	<b>57.5</b> (29.1)	0.698	0.45
Point 4R	7.1( 7.1)	49.8(49.0)	55.2(44.6)	56.6(16.0)	<b>58.6</b> (21.3)	0.692	0.20
Point 5R	3.6( 3.6)	52.7(52.6)	58.0(47.0)	58.6(10.0)	<b>59.8</b> (15.7)	0.719	0.24
Point 6R	2.0( 2.0)	36.4(36.0)	42.9(34.9)	43.6( 5.5)	<b>45.5</b> (10.0)	0.708	0.38
Background rate (Hz)							
QCD	0.01(0.01)	1.16(0.68)	2.10(1.79)	2.15(0.12)	<b>2.35</b> (0.37)	<b>0.098</b>	
t t	0.03(0.03)	0.03(0.01)	0.04(0.01)	0.08(0.01)	<b>0.09</b> (0.03)	0.343	
W j (l v )	0.06(0.06)	0.07(0.04)	0.08(0.01)	0.09(0.02)	<b>0.09</b> ( - )	0.695	
				$\Sigma$	<b>2.53</b>		

\*  $125/180 = 0.694$

# L2 CUTS OPTIMIZATION

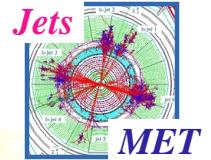


	MET	J2 + MET	J3 + MET	J4 + MET
	150	30 + 130	40 + 110	60 + 90
Point 4	60.7(60.7)	71.0(70.7)	77.0(61.3)	<b>79.6</b> (25.0)
Point 5	53.0(53.0)	62.8(62.3)	71.3(59.2)	<b>75.2</b> (28.1)
Point 6	25.4(25.4)	34.9(34.9)	45.1(41.2)	<b>52.2</b> (26.9)
<b>If optimized separately ...</b> <ul style="list-style-type: none"> <li>● better without <math>\Delta\phi(J_1, J_2)</math> ?</li> <li>● <math>J_1</math> looks useless</li> </ul>				
Background rate (Hz)				
QCD	0.90(0.90)	1.40(1.40)	1.96(1.33)	<b>2.31</b> (0.21)
t t	0.04(0.04)	0.06(0.06)	0.09(0.07)	<b>0.10</b> (0.02)
W j (l v)	0.06(0.06)	0.09(0.06)	0.09(0.02)	<b>0.09</b> ( - )
		$\Sigma$	<b>2.50</b>	

- 👉 If treated separately, Points 4R, 5R, 6R have just slightly higher L2 efficiency than in case of "common" treatment (previous slide)
- MET useless
- J1, J2 and  $\Delta\phi(J_1, J_2)$



# CONCLUSION



- LHC "starting" low-mass scale (low luminosity) mSUGRA points w/wo R-parity violation are considered
- L1 and L2 cuts optimized for given bandwidth (2 kHz and 3 Hz respectively) with simple "genetics" algorithm
- Obtained combination of cuts is a compromise to cope with a variety of possible SUSY scenarios
  - sumET cut seems to be useless @ L1
  - similar cut L2  $M_{\text{EFF}}$  -"- @ L2
  - $\Delta\phi(J_1, J_2)$  is helpful  for "R" points !